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THE METAMORPHOSIS OF DRUG RESEARCH[1]

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THE topic which has been assigned to me for discussion is a broad one, and I am going to consider it from its broadest aspects. It is only a small exaggeration to say that any one who takes as much as an aspirin tablet for himself engages in drug research. I can speak then as one of 130,000,000 drug researchers in this country, but even at that I can only speak with the deepest humility. A short time ago our colored maid developed a cold and with it a cough. I was called upon to do something about it, and I gave her what I considered to be the best medicines available for a cough due to a cold. But the maid had more faith in a medicine of her own selection which I noticed she took to the exclusion of mine. Her faith in her medicine was its own reward and in due course of time her cough fortunately disappeared. I would have exposed myself to polite but silent scorn if I had tried to tell her that neither my prescription nor hers cured the cough—that it would have disappeared anyway, or, as some one put it, "Nature cures the disease while the remedy amuses the patient." I might have tried to show her that man has been subject to colds and coughs since the dawn of civilization and that they have come and disappeared for countless generations before her medicine or mine had been discovered. But it would have been useless. If colds and their coughs hadn't made a habit of coming and going in precisely the same way regardless of what we did for them, man would long since have coughed himself off the face of the earth.

The element of faith has for centuries been one of the most important active ingredients in every medi-

[1] An address delivered before the American Drug Manufacturers Association, May 7, 1941.

cine—even though it is not declared on the label and Congress has completely overlooked it in the Food, Drug and Cosmetic Act.

Drug research had its start about a thousand centuries ago. It began before the dawn of what we choose to call civilization. For more than 995 centuries of this time the scientific method as applied to drug research was unknown. When we consider the empiricism, the "post hoc ergo propter hoc" reasoning, the stupidity that still passes for science today, perhaps we should find some comfort in the realization that sound scientific inquiry in this field has been practiced for less than five centuries—less than the twinkling of an eye in man's history on earth. But it is also discouragingly evident that in a thousand centuries we haven't learned much about drugs.

For untold ages disease and death were considered to be caused by evil spirits and supernatural forces. Obviously, the function of early researches was to find some sure way of warding off these spirits or placating the gods that sent them. Since disease was the doing of the gods, the only qualified experts in such matters were the tribal medicine men, who were, of course, religious functionaries. We see a hang-over of this idea even to-day, particularly in our system of medico-legal jurisprudence which looks upon schools of healing as if they were endowed with some divine right to use human bodies for the practice of their fantastic notions of therapeutics.

The first conception that disease was caused by external spirits acting by remote control later changed to the notion that the evil spirit gained access to the body and resided within it. And with it the job of the medicine man changed, too. He prescribed charms and fetishes such as amulets, rattles or the beating of drums to prevent the evil spirit from entering, or, once having entered, he tried to get rid of it by prayers and incantations. If these didn't effect a cure, he resorted to more demonstrative forms of elimination therapy such as blood letting, catharsis, leeches and opening holes in the skull. Although several thousand years have passed since these ideas predominated, they, too, still influence the therapeutic thinking of to-day. As the mind of primitive man began to free itself from the conception that disease was due to the evil eye or the wrath of the gods, he began to look around for other causes and with it other ways of dealing with them. He thought he observed that illness could be cured by many strange and wondrous means. For instance, a flannel cloth worn around the neck was believed capable of curing sore throats and whooping cough, provided the cloth was red. A horse chestnut was thought to be good as a preventive for rheumatism.

While the royal touch had only a limited vogue as a cure for scrofula, many peasants were certain that all forms of tuberculosis could be warded off by wearing earrings. It was once believed by generations of country folk and a few that I know who were born in Brooklyn that warts were caused by toads and cured by touching them with pebbles or milkweed. Bags of asafoetida were worn around the neck to ward off asthma and croup. While most of us are now pretty sure that there is no danger of lunacy if the moon should shine on us during sleep, it is no mere ancient myth that moonshine causes plenty of trouble. But some of the ancient observations on the cause and cure of disease happened to be right. For instance, savages in widely separated countries learned of the effects of the poppy for various conditions, and cinchona for malarial fevers. The virtues of cod liver oil were recognized long before the word "vitamin" had been thought of. The diuretic effect of foxglove was known to a housewife in Shropshire before the physicians of the time recognized its merits. But all in all early experiences with drugs were empirical in nature and followed a pattern something like this:

An individual is sick.
A drug is given.
If the individual recovers, the drug effected the cure.
If the patient dies, it is easy to excuse the failure by reasoning that not enough of the drug was given, or too much was given, or it was not given early enough.

The same type of fallacious therapeutic reasoning is still commonly practiced to-day by laymen and many physicians.

It was not until the nineteenth century, a gestation period of some 999 centuries, that drug investigators fully realized that therapeutic research was not so simple a proposition. It was not enough to give a medicine to some one who was sick and see what happened. Things often did happen, but how could one be certain that the drug was responsible? Scientists gradually set up criteria by which they could distinguish coincidental occurrences from those that had a cause and effect relationship. These criteria took into consideration six fundamental propositions. They are:

(1) Many diseases and symptoms are self-limited, regardless of what is done for them.

(2) Nature heals and cures; drugs at best are merely adjuvants.

(3) Chronic diseases are characterized by spontaneous remissions and exacerbations.

(4) Symptoms are often entirely due to and almost invariably aggravated by worry and emotional disturbance.

(5) Symptoms regardless of their cause are often temporarily improved through the expectation of therapeutic benefit.

And finally,

(6) The fallacy of *post hoc ergo propter hoc* reasoning.

The tendency of the human mind to indulge in *post hoc ergo propter hoc* reasoning was said by the philosopher Kant to be the cause of all human error.

An understanding of these six fundamental propositions is basic to sound therapeutic research. The failure to take them into consideration and to set up proper controls toward this end has led to an enormous amount of misspent research. As far as the drug industry is concerned, it simply means that millions of dollars are being wasted on drug research that is unsound in its conception. It leads to the promotion of drug products on the basis of fallacious therapeutic claims which is an even greater economic waste for all concerned.

Now it is evident that when the scientific method is applied to drug research and therapeutic claims, it is possible to establish a therapeutic representation as a fact. It is something that can be demonstrated and proved with the same degree of certainty as any other factual material presented in our courts of law. But our courts, which look backward to precedent, still regard therapeutic representations as matters of opinion. Perhaps we can't blame lawyers too much for throwing up their hands in hopeless confusion when one considers the rubbish that is presented to them in the name of science. But we have available nowadays well-recognized techniques for testing the correctness of therapeutic claims. Where there is a diametrically opposed difference of opinion, it is self-evident that one opinion is right and the other wrong. Honest differences of opinion arise only because some one has failed to take into consideration the fundamental principles that apply to drug research in human beings. Where there are such differences of opinion it should not be an insurmountable difficulty to show wherein the evidence supporting one of the conflicting opinions is faulty. And in my judgment our courts have a responsibility to look behind the opinion and critically examine the evidence supporting it. Perhaps this is expecting too much of our lay courts, and the ultimate solution may be in the designation of expert tribunals to judge these admittedly difficult questions.

In the metamorphosis of modern drug research certain interesting trends are evident. Drug research started as the effort of individuals. In the eighteenth and nineteenth centuries we find contributions to drug research made largely by individuals in the course of their medical practices or as by-products of their functions as teachers in universities. From the middle of the nineteenth century, drug research has been gradually taken over by workers in universities, foundations and institutions. The medical practitioner has become increasingly aware of the fact that the ordinary practice of medicine does not provide sufficient time, material and specialized instruments for fundamental and well-controlled experiments. As medical research developed as the function of universities, there came into existence the so-called university hospital or the medical center, as an adjunct to the university. Here there have become available human subjects in sufficient numbers to permit well-controlled scientific studies on the cause and treatment of disease. These institutions were and still are largely private organizations supported by the philanthropy of private individuals. But we are now witnessing a gradual but nevertheless tremendously significant change in this situation. It appears to be only one phase of a vast economic movement that is sweeping over the world. Private philanthropy seems to be rapidly disappearing. A few institutions have been able to coast along on what they managed to hang on to during the economic depression, but by and large they are unable to grow and prosper on endowments that are not augmented. Instead, drug research is being increasingly supported by funds from two sources: (1) the drug houses; (2) the government, using the term in its broadest sense to include states and municipalities. And not only are the funds from these sources flowing into the coffers of our universities, but both the drug houses and governmental units are undertaking increasingly important drug research themselves. They are as never before drawing promising investigators away from the universities into their own laboratories.

Until recently drug houses have confined their efforts largely to laboratory investigations with drugs. They have turned to the universities and their hospitals for their clinical tests. In general, they have exercised little control over the development of these clinical studies except as the aim to please and perhaps attract additional funds may have influenced the investigators. I suspect that this relationship is not always satisfactory from the standpoint of the drug manufacturers, since they pay the money and yet are not in a position to control the direction of the studies. But, on the other hand, it provides what may be said to be a non-partisan, unbiased inquiry into the clinical facts. However, I venture to say that the future will see drug houses obtaining closer and more controlling affiliations with institutions having clinical facilities.

During the last twenty years the tempo of research in the fundamental sciences has been gradually increasing. Those who had a clear vision of the future recognized that the conquest of disease, premature old age and cancer was more likely to be made in the laboratory of the chemist or the physicist than in the clinic where drug research was more often than not practised as a hobby of the medical staff.

During the first quarter of the twentieth century drug research seemed to be suffering from claustrophobia, and chemotherapy in particular was in the

doldrums. But all this suddenly changed in 1932 with the discovery of the clinical usefulness of sulfanilamide. The importance of a close collaboration between laboratory and clinic was reemphasized. Sulfanilamide and intriguing discoveries in the field of endocrinology have unveiled new horizons. The sky seems to be the limit. Scientists are tackling problems of disease, such as the cause of cancer and the prolongation of life, with not only zest and enthusiasm but confident expectation that the achievements of the past are but a minor prelude to discoveries that will transform the whole panorama of life itself.

The enactment of the New Drug Section of the Food, Drug and Cosmetic Act has provided a powerful impetus to drug research. For the first time in our national history a thorough investigation of the safety of drugs before they are marketed has been made compulsory. Thousands of drug investigations are now being conducted where previously there was only a handful. Prominent pharmacologists tell me that this law has provided an incalculable stimulus to a science that was once regarded by some as a sterile cross between physiology and chemistry. Time will show, I believe, that the new drug section of the act is one of the most significant things that has ever happened to drug research in this country and the legitimate drug industry will be among the principal benefactors of its wholesome influence.

There will always be a drug industry and individual drug manufacturers. But some manufacturers will develop and prosper; others will decline. Some will see more clearly than others that the future of their companies rests more than anything else upon the research that is stimulated by them. Others will recognize, as some already have, that we can't make much progress if we have only one, two or three bright young chemists shut up in a laboratory, puttering along on problems that are as vital as health and life, and at the same time somewhere else in another laboratory, one or two other chemists going over exactly the same ground, as out of touch with the first group as if they were working on another planet. The sooner we realize that the day of the brilliant individual investigator working alone in a hermetically sealed compartment is gone forever, the sooner will we solve problems that are far more important than the tensile strength of steel, nylon stockings, synthetic rubber or a horsepower per pound of airplane engine.

The problems of drug research are more complex than they used to be. Progress in the future will come increasingly from the collaborative efforts of groups of individuals, working under the leadership of those who have imagination and minds fertile with ideas. The brilliant investigator is indispensable, but he must have the tools to work with and the help of assistants who will act as test pilots for his ideas. There must also be a harmonious integration of the work of chemists, physicists, physiologists, pharmacologists and clinicians to produce results. I think it is about time that medicine and the drug industry gave up its small-time amateurish attempts at drug research. I think we should go to the du Pont Company, the United States Steel Corporation, the General Electric Company and the Firestone Rubber Company and see how they tackle their research problems. We must enlist the brains, the imagination and the ingenuity of thousands of chemists, physicists, pharmacologists and clinicians to solve these important problems of life and health. They are the problems that count, for without a long life and health, it really doesn't matter much whether we have nylon stockings or synthetic rubber or stratosphere planes or anything else.

ASPECTS OF MODERN PSYCHOLOGY. II

By Dr. CHARLES S. MYERS
ENGLAND

LET us now return to the fate of the psychology founded by Wundt which directly concerned itself in observing mental experience and in reducing it to its elementary terms of sensation and feeling. His former pupil, Külpe, met with Wundt's violent opposition when at Wurzburg he began to study experimentally and introspectively the processes of thought, paying particular attention to the acutely living *acts* of judging, valuing, denying, etc., and not only to the relatively lifeless *stuff*—"bundles" of sensation, percepts, images and thoughts. In Paris, Binet had already detected the occurrence of thinking without images, verbal or concrete. Külpe's school also insisted on introspective grounds that meaning was possible in the absence of images (and hence of sensations). Wundt protested that such inquiries were beyond the scope of introspection, and Titchener, endowed with vivid imagery, maintained that anyhow introspection in Külpe's school must be defective, as he himself could always detect kinaesthetic imagery in all meaning. Meaning, he said, is invariably "context"; it involves a bodily attitude of the individual facing the situation; and psychologically meaning *is* the characteristic kinaesthetic experience aroused by that bodily attitude. Few psychologists will now insist that meaning must have a sensational (or imaginal) basis, or that thought must always have imagery as its vehicle.

Equally important was the experimental evidence

adduced by Külpe's school in favor of the wide influence of the "determining tendency" and "attitude" which, once set up, influence the nature and direction of future mental processes. We try in vain to recall a forgotten name: this effort evokes a "determining tendency" that continues to act unconsciously until, it may be, more favorable conditions being established, the forgotten name arises unbidden to consciousness. Or again, when the figures, say, 3 and 9, are presented to us, we may by "chance" association at once think of 12 or 27 or 6 or 3; but if previous instruction has given our minds a "set" in the direction of addition or multiplication or subtraction or division, an "attitude" has been formed which will result not in *any one* of these numbers, but in the *appropriate one* of them, at once appearing in consciousness.

A determining tendency is something very different from an associative tendency. It is a purposive perseveration, a goal-seeking drive, capable of using alternative mechanisms for procuring its end, whereas an association is a mere coupling or mechanical connection, of variable strength, rigidly uniting the terms *a* and *b* associated. Obviously, as has been urged already, mere association strength is not sufficient to explain the results of mental activity in daily life. Repetition of *a* and *b* merely increases the strength of such connection, whereas with purposive activity and, in particular, the determining tendency (to use an example of Lewin's, where *a* is the desire to post a letter, and *b* is the sight of a mail box) the connection virtually or wholly ceases when once the goal has been achieved.

But it would be absurd to assert that association plays little or no part in the operations of the mind. Yet this of late has been the tendency of certain schools of psychologists who have rightly recognized its limitations. Laboratory experiments with senseless syllables show irrefutably that under these abstract, artificial conditions the process of association takes place in learning them and indeed that the strength of association and perseveration are the principal factors determining their recall. Under more natural conditions, however, when sensible material has to be learnt, the mechanical process of association is overshadowed; but even here it becomes more prominent, the simpler and the poorer in meaning be the material that has to be learnt, the simpler be the mind of the learner, or the less liable be what has been learnt to the distortions of interest and to the perspective influences of what F. C. Bartlett has termed "schemata."

It is similarly absurd to condemn sensations to nonexistence in a diatribe against the dangers of the crude mosaic atomism to which I have already directed attention. We know perfectly well from experience what a fairly pure sensation is and how it differs from a perceived object. We may be ready to admit that percepts are not built up mosaically out of sensations, that, on the contrary, vaguely meaning percepts came first in the developing experience of the infant and that pure sensations came later to be differentiated from them by abstraction. But it would be ridiculous to deny that mental life is served by integration as well as by differentiation. I recall the experience of an artist friend of mine who was painting a street in the bazaars of Cairo. Behind him stood a crowd of *fellahin,* gaping in astonishment at his work. At length he heard one of them, presumably of higher intelligence than the rest, slowly say, "That's a door, that's a window, there's a roof," and suddenly, "Why it's a house!"

In rebellion against the extravagances of mosaic atomism and of associationism, nevertheless, and welcoming introspection, the *Gestalt school* was founded by Wertheimer, with the energetic support of Köhler, Koffka and Lewin, all four of whom have found a happy refuge in the United States of America from recent German intolerance. The importance of form, shape and pattern has also been incorporated into Krüger's school of *Entwicklungspsychologie,* succeeding Wundt's, at Leipzig. The *Gestalt* psychologists have studied the laws determining the forms, and the stability and changeability of the forms, of optical figures, and the relation between the figure and the ground from which it stands in relief or in which it may be almost unrecognizably imbedded; and they have applied these laws also to conditions affecting certain intellectual and conative processes. They have studied the occurrences and the dynamics of what they interpret as *Gestalten* in the physical field; they have claimed to find analogies between these *Gestalten* and those in the psychological field; and indeed some have tried to trace physiologically corresponding, "isomorphic" patterns (with their stresses, tensions and pictorial vectors) within the sensory and nervous systems (in terms of electric potential or osmotic pressure)—a psycho-physical parallelism in *Gestalten* which it is hard to accept in any strict sense when meanings, values, traits, drives, purposes and personalities are considered. Stern, suspicious of a repetition of a mosaic of entities, here of *Gestalten,* once criticized this school in the words "Kein Gestalt ohne Gestalter." But of late Lewin, one of its leaders, has been busy trying to "patternize" personality itself, and has been likewise treating the environment in a "topological" way, introducing an applied "mathematical topology" and endeavoring apparently by a development of *Gestalt* and dynamic psychology to found a school of *topological psychology.*

Like others who have become habituated to any one

outlook, the *Gestalt* school tended at first to belittle every other outlook and to bring within its ambit too much that would more readily and with greater likelihood be explicable in other terms. To study patterns already formed need not involve neglect of, or contempt for, the study of the parts apart from their combination. It may well be, as the *Gestalt* school urges, that the true significance of any part of a whole can not be realized until the properties of the whole are understood. And it is unquestionable that errors of interpretation ensue from the study of abstract "vivisected" parts of the whole mental (as of the nervous) system. But whatever the size of the whole that is investigated, it must in practice be only a part abstracted from a still larger whole.

Lewin does not share the view that psychology need use the same dynamic concepts as physics uses, nor that all psychological explanations need rest ultimately on physical facts; he does not see the necessity for accepting "the philosophical Utopia of a single universal science." The "topological" concepts which he introduces in the form of spaces, boundaries, distances and directions are mathematical, not physical in nature. They represent, he tells us, an attempt to treat psychology by means of applied mathematics, using a concept of space (developed by mathematics from the part-whole relationship) which is by no means identical with physical space—thus providing a visual and dynamic representation of behavior which is for him a function both of the person and of his environment. "Topological" space implies that we are dealing with mathematical relationships which can be characterized without measurement.

Whether we can by Lewin's methods replace anthropomorphic explanations by purely mathematical concepts and relations of this attractive and promising kind must be left to the future. The problem is conceived in a clearly different spirit from that which in physics causes controversy between experimental and mathematical physics, and from that which faces the measurement of psychical processes (*e.g.*, of sensation by Fechner and of abilities by deviations from the average scores at mental tests) and the determination of unit mental abilities or qualities by the mathematical methods of factorial analysis. There is a general agreement that sensations can not be measured, at all events in the same sense as physical objects; and that Fechner's law can only be reached by the aid of mathematical operations which treat the symbols in utter disregard of what they psychologically stand for. The psychological standpoint is deliberately discarded during the application of such mathematical methods, and thus the resulting formula, though not without its uses, is not without its difficulties.

The labors of the *schools of factorial analysis,* especially of Spearman, Thomson, Stephenson and Burt in Great Britain and of Thorndike, Thurstone, Kelley, Hotelling and others in America, will undoubtedly bear useful fruit. But the concept of mental factors, like that of faculties long ago, needs to be carefully watched. Can the mind be in complete truth conceived as having a structure of ultimately independent unit factors, some "general" to a very large number of mental processes, others perhaps common to a comparatively small "group," others "specific" to particular mental processes? Is character, for instance, to be conceived as an aggregate of separate traits and other unit factors? Are the units independent of the whole? Has the whole no influence over the complexion of its parts?

When in factorial analysis we determine the correlation between any two abilities, we are correlating the scores made at pairs of tests, that is to say measurements of *behavior,* of outward expression or movement. How can we legitimately pass from this to the correlation between *psychological* processes? Any one mental test (like any complex muscular action) can be performed by any one person now in one way, now in another, using different mental abilities (as, in the case of complex movement, using different muscles) to achieve the same end. And when the factors have been mathematically analyzed, what is their *psychological* nature? This can only be guessed at, and the guesses confirmed by their proven utility. Then, again, what psychological warrant have we for the various mathematical steps we take in factorial analysis? Have they at each stage strictly psychological meaning, or are we neglecting this for purely statistical operations which end with results that relate to the average, but have no precise reference to any individual member, of the group? And yet in some general way, for broad common traits and for the total group, factorial analysis, like the enumeration of a few common instincts, proves useful and deserving of encouragement, although it must fail for the unique characters of the personality of the individual. In this direction there is greater promise in a variant of factorial analysis which has been specially urged by W. Stephenson and C. Burt. Here pairs of tests applied to a group of persons are replaced by a group of tests applied to pairs of persons.

Factorial analysis has already indicated the likely truth that special abilities are less highly differentiated from one another in early childhood than at adolescence, thus providing analogy with the view, supported by experimental evidence, that in the developing organism the central nervous system is originally undifferentiated in function as well as being relatively structureless. As Coghill has stated, "dominant organic unity," "undifferentiated reactions of the whole organism," are present from the beginning: the form

of the pattern of behavior is not "simply a combination or coordination of reflexes" originally isolated from each other.

One outstanding difficulty is that the number of factorial units analyzed from any one set of data depends on the nature of the mathematical operations employed. Herein the various schools of factorial analysis at present differ, reaching interpretations of any specific investigation as different from one another as the schools of Freud, Jung and Adler in their analysis of the role of the unconscious would reach in any particular case. For Spearman factorial analysis yields each time but two factors—a "general" factor known in some circumstances as general intelligence and a "specific" factor peculiar to each ability. Associated with this finding has developed his *neo-genetic school,* which refuses any countenance to *Gestalt* principles and spreads its net far more widely than can be suitably covered by its two most important principles—the "eduction of relations" and the "eduction of correlates." Their value is particularly evident in clarifying the definition of general intelligence.

Wherever we turn, whatever methods we consider, it would seem that both the total wholes and the component parts require appropriate study in order to arrive at a true and complete psychology. Once again, we are forced to the conclusion that psychology needs to be studied not only from the mathematical and the mechanistic but also from the humanistic and teleological standpoints, and alike from the introspective, behavioristic and *Gestalt* standpoints, according to the purpose which the study is intended to serve and the conditions under which the study is undertaken.

At a time when physicists are complaining that they do not know now what mechanism means nor what matter means, when many of them realize that what "scientific" or mathematical investigation has to say about the universe represents by no means all that is significant about it, when biologists recognize self-conservation—the struggle of organisms for their existence—and are no longer confident about the blindness of evolution, it would be rash to condemn any standpoint or any school of psychology among those we have examined. We may justly complain that any single current concept, *e.g.,* that of the reflex, of association, of *Gestalt,* or of factors, is inadequate, and that broader or multiple concepts are desirable. At the present time we observe a growing tendency of these schools to welcome each other's features that can usefully blend together. Orderliness and teleology are not inconsistent with one another: generalization and individuation are of equal importance. We have good reason, in view of the many-sidedness of psychology, to welcome, not to deride or to suspect, the active energy displayed by its various schools—so long as intolerance, injustice and the other evils common to dictatorship and totalitarianism are avoided. We have only to look back a half-century to realize the enormous strides that psychology has made, in refinement and expertness of introspection, observation and interpretation, in delicacy of discriminating terminology, in the conception of the unconscious, in the application of mathematical methods, diversity of aims, concepts and methods of approach and in the rich harvest that has resulted from the uses of psychology as an applied science.

OBITUARY

EUGENE DAVENPORT

EUGENE DAVENPORT was born in Woodland, Michigan, on June 20, 1856, and died in his old home on March 31, 1941. His parents were pioneers and the boy was brought up under pioneer conditions. While helping his father on the farm as a lad he made up his mind to get a college education. In due time he entered the Michigan State College of Agriculture, receiving the B.S. degree in 1878. This was followed by the M.S. in 1884, the M.Agr. in 1895 and the LL.D. in 1907. In 1920 Iowa State College conferred on Dean Davenport the LL.D. degree, as did the University of Kentucky in 1913 and the University of Illinois in 1931.

The ten years immediately following his graduation from college were spent in operating the home farm. In 1881 he married Emma J. Coats. They had two children, one of whom died in infancy. In 1888 he was appointed assistant botanist at the Michigan Agricultural College and Experiment Station and the following year was made professor of practical agriculture and superintendent of the college farm, a position which he held for two years. The year 1891–92 was spent in São Paulo, Brazil, as president of the Collegio Agronomica. Owing to the failure of that institution to receive government support, Dr. Davenport returned to the United States and in 1895 and 1896 was appointed dean of the College of Agriculture and then director of the Experiment Station of the University of Illinois. Here his great career really began. His task was to build a college and put agricultural education on a college level. In order to accomplish that purpose it was necessary to change public sentiment in the state.

When Dean Davenport went to Illinois there was a college of agriculture only in name. It was not that there was no work in agricultural education being done, but it was on a low level and wholly unsys-

tematized. There were only a few students. He found opposition both in and out of the university. The prevailing opinion was that the farmer did not need education, or if he did it should be vocational in a narrow sense. Dean Davenport had a different view. He believed that every young person should be educated both culturally and vocationally. He often remarked that what is technical and professional to one is humanistic to another and that "every man to be efficient needs the vocational; to be safe and happy he needs the other." He held the view that the country needed not "half men" but "whole men" in the sense that each should be man, citizen and farmer.

These views led the dean to insist on a college level for agricultural education and to oppose separate vocational schools. He insisted on a single system of secondary schools in which the people of all classes should be educated together with different courses of study for different classes.

He worked through the earlier years to get these views accepted before he could get the necessary support. As one of his colleagues has remarked: "Thus did Dean Davenport exert his powerful faculties towards seeing that instruction of less than college grade should be broadly developed in the secondary schools and that it should be developed as a part of a unified system of secondary education. Perhaps this is the most significant contribution which the university has made in the development of agricultural instruction at the sub-college level."

Public sentiment slowly changed, influential farmers were converted and through their support adequate appropriations to develop the college and experiment station were secured and an agricultural building was finally erected in 1900. The dean soon gathered around him an able staff in both the college and the experiment station.

From researches conducted in the experiment station have come discoveries that have added largely to the welfare of the people of the state. Without lessening in the least degree the credit due members of his distinguished staff, it may be truly said that Dean Davenport participated in every line of investigation, although he always gave the credit to others. He took an active part in developing the system of permanent agriculture, the soil survey and many other research projects. Concerning the policy of a permanent agriculture he wrote: "It can easily be shown that good farming which cares for the soil by restoring fertility as fast as it is taken out, can be made to pay the farmer better over a period of years than poor farming which destroys fertility."

Dean Davenport's views on education and agriculture are set forth in four books and numerous pamphlets. The books are: "Principles of Breeding," "Education for Efficiency," "Domesticated Animals and Plants" and "The Farm." These volumes and the numerous addresses frequently given in the state led in a few years to a complete change of attitude on the part of the farmers towards higher agricultural education. Indeed, so great was the change of public opinion that, as the dean often told me, he found it necessary at times to check impulsive projects designed to stimulate more rapid development. He always succeeded in this, even to preventing a movement for separating the College of Agriculture from the rest of the university. The confidence of the people in his judgment was deep and wide-spread. Indeed, it may be said of him that the College of Agriculture was in reality a creation of his own. The confidence of the people rested not only on the obvious sanity of his plans, but also on the fact that he had a thorough knowledge of practical farming and could speak to the farmers of the state as one of themselves.

When the World War came to us in 1917, Dean Davenport took an active part as an adviser of Mr. Hoover in promoting a food policy for the country. He and his colleagues outlined such a policy with the idea of having their proposal enacted into law. At the dean's request I personally took their recommendations to Washington, where they were incorporated into a bill and introduced in one of the houses of Congress. However, it was obviously desired to have such a project originate with the existing administration. Therefore the bill was never brought to a vote, although the policy finally adopted was substantially that embodied in the bill.

A true estimate of Dean Davenport as a citizen and educational leader can not be formed without a glimpse at what may be called his social philosophy. This is well set forth in the latter part of his last book, "The Farm." He remarks: "The conscientious farmer will remember that while his first duty is to himself and his family, yet, after all, he holds his land in trust because the man who comes after him will also have a family and will also have problems of his own to be met. He has no more right to skin the land for his own profit than has a business to issue long-time bonds for expenditures whose benefits will be gone before the people are born who will pay the bonds." This is an application of the sound doctrine that in industry and the professions the element of the public interest is always present and should never be forgotten.

The dean had some views in these later years on the Federal agricultural policy. He praised the liberal policy of previous years which promoted agricultural education and such projects as flood control, drain-

age and similar activities. He believed, however, that "To go further than this and attempt to coerce in the management of land, as is often suggested, is of doubtful expediency. . . . One thing is certain, agriculture can not be hampered by any form of gigantic administrative machinery, governmental or private." To the end he believed in individual initiative and self-reliance as the primary conditions of success. He expressed these views to me in his home only a few months before he died.

Dean Davenport also had pronounced views on the international situation. In an article written for the United States Boys' Working Reserve during the World War, he wrote: "Unless we win this war, all the world will work for Germany. She has a definite plan for the conquest of the earth, a piece at a time, and whosoever she conquers will be bled white. . . . Germany has been getting ready for this war for forty years." He quotes Bismarck as saying, "For a hundred years war must be the chief industry of Germany, and every war must pay for itself with a profit." So the dean goes on to remark, "Germany has threatened to bleed France and England and America, and so she will in good time if she comes out of this war with her army." These words might have been written in 1940 instead of 1917.

Dean Davenport did not limit his interest to education and agriculture. He was interested also in the fine arts and the proper use of leisure. Once in a while he emphasized his interest in the latter by taking extensive tramps with his family in various parts of our western land. "Vacation on the Trail" is a delightful story of their experiences in high mountain trails and a fine illustration of a good use of leisure.

Broadminded, liberal in his views, always courteous, helpful in his attitude, sound in his judgment and devoted to his ideal of duty, he was a tower of strength in the University of Illinois and the agricultural circles of our country. His influence will last down through the years.

DAVID KINLEY

URBANA, ILL.

RECENT DEATHS

DR. GEORGE ELLETT COGHILL, member of the Wistar Institute of Anatomy, Philadelphia, where he was from 1925 to 1935 professor of comparative anatomy, died on July 23 at the age of sixty-nine years.

FREDERICK WILLIAM HEHRE, head of the department of electrical engineering at Columbia University, died on July 27.

THE *Journal* of the American Dental Association reports the death of Dr. Robert Boyd Bogle, Nashville, on May 25; Dr. Edward Jay Tinker, Minneapolis, on May 8, and Dr. John Albert Marshall, San Francisco, on May 7.

PROFESSOR THOMAS GIBSON died at Kingston, Ontario, on July 2 at the age of seventy-five years. At the time of his death he was professor of the history of medicine and earlier was professor and head of the department of pharmacology of Queen's University, Canada.

SCIENTIFIC EVENTS

AMERICA AND BRITISH SCIENCE

DR. H. H. DALE, director of the National Institute for Medical Research, London, and president of the Royal Society, has sent the following communication to *The British Medical Journal:*

Some of your readers may have seen my letter to the *Times* of June 20, on the generous gifts recently made to the Royal Society by scientific societies of the United States of America—an earlier one of $10,000 from the American Philosophical Society "for the aid of science in Britain," and now, last week, a gift of $5,000 from the American Physiological Society "for the support of scientific publications in Britain, especially in physiology."

A natural and helpful comradeship between medical men of different countries has always been at least as strong among the physiologists as among those whose work is in other branches of medical science or practice. Certainly we British physiologists are on terms of sufficient intimacy with our American colleagues to know well that the American Physiological Society, like our own, depends for existence and support on the efforts and the contributions of members who are working men of science. Their gift will assuredly have a direct importance for the object which they named in making it; but while we gratefully recognize its immediate and intrinsic value, we shall not miss the wider meaning of the fraternal impulse which determined this fine and generous action. We shall be sure that it symbolizes a desire of our American friends to share with us, as far as national policies allow, in the losses which are being encountered in defence of ideals which are theirs as much as ours.

Such gifts, indeed, are among many signs of the fuller understanding which comes with the recognition of a common peril and a common duty. An interchange of medical personnel has begun. The generosity of the Rockefeller Foundation is enabling a chosen batch of students to go to American medical schools; there must certainly be more of such interchange after the war, and in both directions. Qualified American medical volunteers are arriving in this country. Close collaboration in scientific researches more directly concerned with warfare has for some time been

a necessary and well-established condition of America's share in the equipment of our forces. Surely it is clear that the greatest gain which can come to us, and to the world, from a war in which so much has been and must yet be sacrificed, is this closer and more conscious unity between peoples who have always been bound together, not merely because they speak the same language and share so much of history and tradition, but because their ideals and their outlook on life are, in very truth, essentially identical. To see in the promotion of such unity the best hope for the future, to work for it in every way and to guard it from the weakening effects of sectional aims and factitious differences, seems to be the best acknowledgment that the medical and scientific men of Britain can at present make to the American colleagues who, with a noble and simple generosity, are showing their desire to be identified with our cause.

THE INSTITUTE OF TECHNOLOGY OF NORTHWESTERN UNIVERSITY

IT is expected that the new building of the Institute of Technology of Northwestern University, erected at a cost of $6,735,000, which was made possible by a grant from the Walter P. Murphy Foundation, will be opened in the autumn. The institute is conducted on the cooperative plan, under which students alternate work in industry with study in the classroom on a quarterly basis. The first class entered in the autumn of 1939.

In the new building there is an air-distribution room, where the mercury will reach zero, designed so that smaller rooms may be constructed within, thus permitting control of external temperature. This room will test for air leakages, insulation defects and strain upon building materials.

The cold room for civil engineering, to which specimens of cement, concrete, steel and building materials will be brought for analysis, is a heavily insulated 6 by 7 foot laboratory, in which quick changes in temperature will subject materials to the most rigorous of tests.

A low temperature research room is being built for the department of mechanical engineering. In a compartment large enough to house an automobile, the temperature may be driven to 75 degrees below zero. Tests will be conducted under these conditions of moving engine parts. The room is insulated with twelve inches of cork. It is tile covered and separated by an air space from the ground beneath. The latter permits the floor to expand or contract as the temperature varies.

Special research in low temperatures is planned for the cold room of the department of physics, where temperatures of 20 degrees below can be produced. In addition, chemistry will have two "variable temperature compartments," which will reach 4 degrees below. These rooms will serve the purpose of storing organic samples which need to be kept frozen.

Besides the so-called "cold rooms," there will be thirty-two controlled temperature rooms, cooled by a seventy-five horse-power air conditioning machine in the basement. These will be used for a variety of experiments calling for specific temperatures.

Approximately $1,000,000 worth of new equipment is now being installed. This includes apparatus for producing lightning and rain to test insulation and electrical equipment, "bomb rooms" with 12-inch walls to guard against explosions from experimentation, an artificial river to test boat models and vibrationless rooms which float in space.

THE NATIONAL FOUNDATION FOR INFANTILE PARALYSIS

THE distribution by the National Foundation for Infantile Paralysis of grants amounting to $195,030 with which to carry on its battle to conquer infantile paralysis has been announced by Basil O'Connor, New York, president of the foundation.

These grants include:

A grant of $40,000 to the newly organized School of Public Health at the University of Michigan, which continues aid given to the school to create facilities for the study of virus diseases and to train virologists, with particular emphasis on infantile paralysis; also a grant of $7,400 has been made to the department of pediatrics of the university for the purpose of investigating the various forms of treating experimental infantile paralysis by the use of biologic and chemical agents.

A grant of $4,250 has been made to the Medical School of the University of California, San Francisco, to continue a study involving precise analysis of the movements of the various joints of the body, a project of particular importance in the treatment and prevention of after-effects of the disease.

A study aimed at determining the disposition of the infantile paralysis virus neutralizing antibodies among residents of an urban community, under what circumstances and at what rate persons develop such antibodies and the correlation of these data with the occurrence of infantile paralysis will be made under a grant of $9,300 to the School of Medicine of the Johns Hopkins University.

Two grants amounting to $6,300 to the Children's Hospital, Boston, will make possible the continuation of a study aimed at determining the effects of infantile paralysis on the growth of lower extremities. A study of the gastrointestinal tract as the portal of entry of the virus in paralysis will be made under a grant of $3,000 to the Boston City Hospital. Under a grant of $9,200, the Strong Memorial Hospital, at the University of Rochester, will continue studies to determine the functional indices in normal and abnormal locomotion. The University Hospital of the State University of Iowa, under a grant of $7,100 will continue an evaluation of treatment in the

return of muscle function and the prevention of deformity in acute and subacute infantile paralysis. Two grants amounting to $7,930 to Michael Reese Hospital, Chicago, will permit a continuation of previous studies in various aspects of the treatment of infantile paralysis and some aspects of the after-effects of the disease.

Grants amounting to $23,400 have been made to the National Organization for Public Health Nursing, New York, one of them to continue a previous grant to encourage nurses with desirable qualities to prepare themselves for the field of orthopedic public health nursing; another will continue aid to provide seven scholarships in orthopedic nursing care. A grant of $8,500, made to the National League of Nursing Education, New York, will provide instruction of nurses whose main interests are the care of orthopedic patients in institutions.

Other grants include $5,600 to the University of Minnesota; $4,980 to the department of bacteriology and parasitology of the University of Chicago; $5,000 to the department of bacteriology of the University of Southern California; $13,900 to the Bureau of Laboratories of the Michigan Department of Health; $5,300 to the City Hospital at Cleveland, and $12,000 to the New York State Department of Health. Smaller grants are made to various institutions.

SURVEY OF INDUSTRIAL RESEARCH

A COMPREHENSIVE report by the National Research Council on "Industrial Research" has been transmitted to Congress by the National Resources Planning Board. The document is one of a series on Research Resources being prepared by the National Resources Planning Board with the assistance of scientific councils and committees.

The survey was conducted by members of the National Research Council as operating agency of the National Academy of Sciences, with funds provided by the National Resources Planning Board. A committee of the council responsible for the survey, with F. W. Willard, president of the Nassau Smelting and Refining Company, as chairman, was composed of industrial executives, research directors and representatives of universities active in industrial research. The immediate direction of the survey was placed by the council in the hands of Raymond Stevens, vice-president of Arthur D. Little, Inc., of Cambridge, Massachusetts. With him were associated Dexter North, of Washington, D. C., and Dr. Caryl P. Haskins, president of the Haskins Laboratories in Schenectady, as assistant directors of the survey. Representatives of the interests of industrial laboratories, universities and special research institutions prepared sections of the report.

It is pointed out that the continuous and increasing application of science by industry is "contributing most significantly to the high standard of American living." American industry employs more than 70,000 workers in over 2,200 laboratories at an estimated annual cost of $300,000,000. Industrial research is generally accepted "both by informed labor and by informed management as a desirable and constructive force." "Organized labor is officially on record in favor of research and the annual reports of many of the most successful corporations have stressed the relation of research to earning power."

Among the findings set forth by the committee are the following:

> Industrial research is possible for all industrial units, small and large. The distribution of research in industry seems to follow no definite rule but to depend rather upon management policy. It is apparent that research is most active in companies utilizing technically trained men in design, production or sales activity.
>
> Industrial research acts as a protection against unfavorable changes taking place both within and without an industry. Industry looks to the universities for trained technical men, and for principal advances on the frontiers of science. However, it is of interest that advances are not infrequently made on these frontiers in the course of research projects originally designed to achieve immediate commercial objectives.
>
> The United States is now virtually independent of foreign sources for adequate apparatus and facilities for laboratory research.

It is recommended that leaders in several industries take steps toward initiating research programs where they do not now exist. There are wide variations between amounts spent in various industries, the chemical industry leading in the percentage of income devoted to research.

One portion of the report deals with the extent to which the recognized disciplines of science—physics, chemistry, mathematics, metallurgy, the several fields of engineering, biology and borderline fields—are applied in different industries.

It is pointed out that:

> In several branches of pure and applied science, abstracts of the technical literature are supported by scientific societies. Such support is becoming increasingly burdensome and increasingly inadequate in the face of the enormous and rapidly expanding amount of technical matter being published. An excellent means of Government contribution to industry would be proper provision for systematic and complete publication of abstracts of scientific and technical literature.
>
> Extension of research means increasing dependence upon adequate and correct standards of reference. Establishment of standards requires most exacting and long-continued laboratory work, a high caliber of technical personnel, and, frequently, expensive facilities. There is need for much more research on standards of measure-

ment than is now conducted, and it is recommended that the National Bureau of Standards be given encouragement and increased tangible support for research on standards. It is also recommended that any appropriations for such support provide ample funds for adequate publication and distribution of the Bureau's findings.

In transmitting the report to President Roosevelt, the National Resources Planning Board said: "We endorse in principle the findings and recommendations of the special committee and wish to call attention to the great importance of industrial research in relation to both the present defense effort and also to developments in the post-defense period."

In a letter to Dr. Frank B. Jewett, president of the National Academy of Sciences, and Dr. Ross G. Harrison, chairman of the National Research Council, Mr. Willard said: "It is my duty to record here the gratitude of your committee to the leaders of private enterprise in the United States of America who have, without exception and without reservations, responded to your committee's request for information. Lacking this wholehearted cooperation, your committee's task could not have been performed."

SCIENTIFIC NOTES AND NEWS

DR. JEROME C. HUNSAKER, head of the department of mechanical engineering at the Massachusetts Institute of Technology, has become coordinator of research and development for the Navy. He will be assisted by a special board, to be composed of representatives of the chief of naval operations and the commanding officers of the Bureaus of Ships, Ordnance, Aeronautics and Yards and Docks.

DR. WILLIAM F. DURAND, professor emeritus of mechanical engineering at Stanford University, has been appointed a member of the National Advisory Committee on Aeronautics. He succeeds Dr. Robert E. Doherty, president of the Carnegie Institute of Technology, who resigned his membership on July 3 to become chairman of the Production Planning Board of the Office of Production Management.

THE medal of the Society of Chemical Industry has been awarded to Dr. Elmer K. Bolton, chemical director of the E. I. du Pont de Nemours and Company, in recognition of his work in connection with the development of neoprene, nylon and synthetic rubber. The medal "may be awarded annually to a person making a valuable application of chemical research to industry."

THE Rivers Memorial Medal for 1941 of the Royal Anthropological Institute of London has been awarded to Dr. Diamond Jenness, ethnologist of the National Museum of Canada, for his work among the Eskimos of Arctic America. The Wellcome Medal for 1940 has been awarded to Dr. Audrey I. Richards for her essay on "Bemba Marriage and Present Economic Conditions." Dr. Richards has filled the post of lecturer in social anthropology at Bedford College for Women, the London School of Economics and the University of Witwatersrand. She has made anthropological expeditions to study the tribes in Northern Rhodesia.

THE honorary degree of doctor of letters was awarded at the commencement exercises of Jefferson Medical College, Philadelphia, to Dr. John M. T. Finney, emeritus professor of surgery at the School of Medicine at the Johns Hopkins University.

FRANK B. COOPER, research chemist at the Institute of Pathology of the Western Pennsylvania Hospital, Pittsburgh, received an honorary doctorate of science at the sixty-fifth annual commencement of Grove City College, Pa.

AT the commencement exercises of the Philadelphia College of Pharmacy and Science, the degree of doctor of science was conferred on Dr. Victor O. Homerberg, formerly a member of the department of chemistry of the Massachusetts Institute of Technology, and on C. P. Dubbs, of Chicago, in recognition of "his outstanding contributions to the field of industrial chemistry."

A PORTRAIT of Dr. Torald H. Sollman, professor of pharmacology and materia medica at the School of Medicine of Western Reserve University, given by six hundred alumni and friends, was presented to the university during commencement week. A book containing the names of those who gave the portrait was presented to Dr. Sollman.

THE thirtieth anniversary of Dean R. B. Dillehunt's joining the faculty of the University of Oregon Medical School was celebrated on July 10 by a faculty dinner and by the unveiling of a portrait.

IN a wireless dispatch to *The New York Times*, dated July 5, it was stated that Dr. Carrel had been commissioned by the Vichy government to organize in France in the occupied zone an institute for scientific and medical research. This dispatch was quoted in SCIENCE for July 11. We are informed that this information is not correct. Dr. Carrel is at present in occupied France. He fully intended to return to

New York after completing the investigations that he undertook on his own responsibility of the effects of malnutrition and infectious diseases in Spain, France and Belgium, especially among the children.

ACCORDING to *The Lancet*, the following have been appointed to the council of the Imperial Cancer Research Fund for the ensuing year: *Chairman*, Professor H. R. Dean; *Vice-chairman*, Sir Cuthbert Wallace; *Elizabeth Wills Allen Fellow*, Dr. L. Foulds, and *Alice Memorial Fellow*, Dr. R. J. Ludford. Professor James Young has been appointed a governor of the fund by the Royal College of Surgeons of Edinburgh, and Professor T. J. Bosworth, by the Royal Veterinary College and Hospital.

AT the annual general meeting of the Marine Biological Association of the United Kingdom, Professor J. Gray was elected chairman of the council in place of Professor E. W. MacBride. Other officers were reelected.

PROFESSOR LEON BRILLOUIN, of the Collège de France, will be in residence as visiting professor of physics at the University of Wisconsin for the academic year 1941–42. He will offer, in addition to other courses, a series of lectures on short radio waves, their properties, generation, propagation and applications.

DR. ALBERT H. PALMER, formerly of New York University, has been appointed Smith, Kline and French Laboratories research fellow with the rank of assistant professor in the department of agricultural and biological chemistry at the Pennsylvania State College. He succeeds Dr. William G. Gordon, who has joined the staff of the Protein Division of the Eastern Regional Research Laboratories in Philadelphia.

DR. WILLIAM ALLAN, Charlotte, N. C., has been appointed head of a department of eugenics at the new Bowman Gray School of Medicine of Wake Forest College, N. C., which is to open in Winston-Salem in the autumn. The department will be financed by a grant from the Carnegie Foundation of New York.

DR. FRANK HORTON, professor of physics in the University of London, has been reelected vice-chancellor of the university for the year 1941–42.

PROFESSOR H. MUNRO FOX, since 1927 professor of zoology in the University of Birmingham, has been appointed to succeed the late Professor George A. Boulenger as head of the faculty of zoology at Bedford College, London.

AT the Cornell University Medical College, New York City, Dr. Eugene L. Opie has been made emeritus professor of pathology; Dr. John C. Torrey, emeritus professor of epidemiology, and Dr. Joshua E. Sweet, emeritus professor of experimental surgery.

DR. HARRY MILLER LYDENBERG, director of the New York Public Library since November, 1934, and a member of the library staff since July 1, 1896, has resigned. He will be succeeded by Franklin Ferguson Hopper, chief of the circulation department, who joined the staff of the library in 1914.

THE Rockefeller Foundation has made a grant to the University of Oxford of £900 for the Nuffield department of surgery to pay the salaries of Dr. Eric Guttmann and a trained social worker in psychiatry. Dr. Guttmann will carry out an investigation into brain injuries. The university is making a grant to the department of biochemistry to carry out a nutritional survey and a study of antiseptics in relation to burns.

STANFORD UNIVERSITY has announced a gift of $65,000 from the Rockefeller Foundation to finance a five-year program for the development of the electron microscope. It will be under the direction of a committee including Professors Philip A. Leighton and J. W. McBain, chemistry; E. W. Schultz, bacteriology; C. V. Taylor and L. R. Blinks, biology; D. L. Webster and Paul Kirkpatrick, physics; Fred Terman and Karl Spangenburg, electrical engineering. Dr. L. Marton, formerly of the University of Brussels, who came to the United States in 1938, has been appointed associate professor of electron microscopes. Dr. Marton has been working in the R.C.A. Research Laboratories at Camden, N. J.

DR. ROY E. CLAUSEN, professor of genetics at the University of California, has spent six weeks in Hawaii as the guest of the three agricultural experiment stations in Honolulu: the Hawaii Agricultural Experiment Station at the University of Hawaii, the Experiment Station of the Hawaiian Sugar Planters Association and the Experiment Station of the Pineapple Producers Cooperative Association. During this time he gave a number of lectures and consultations on subjects of genetics and plant breeding.

PROFESSOR RENÉ WURMSER, of the Institut de Biologie and of the Sorbonne, Paris, has now taken up his post in Rio de Janeiro, at the Laboratorio da Biofisica of the faculty of medicine. He would like to have communications from his colleagues in the United States and reprints sent to that address.

THE officers charged with the arrangements for the tenth International Ornithological Congress, which was to have been held in the United States in 1942,

announce that the proposed meeting has been indefinitely postponed.

THE autumn meeting of the American Electrochemical Society will be held in Chicago from October 1 to 4, under the presidency of Raymond Ridgway, of the Norton Company, Chippawa, Ontario, Canada.

A MEETING of teachers of astronomy will be held at the Yerkes Observatory on Sunday, September 7, at 2:30 P.M. There will be an exhibit of astronomical texts, elementary and advanced, popular books on astronomy, periodicals, laboratory notes and equipment, diagrams, charts and lantern slides. Those who wish to exhibit material should send it to Yerkes Observatory, Williams Bay, Wis., in care of Dr. Jesse Greenstein. Questions concerning possible exhibits should be addressed to him or to John H. Pitman, Swarthmore College, Swarthmore, Pa.

THE third annual meeting of the Midwest Academy of Sciences of Kansas City, Mo., was held at the Junior College Building from June 26 to 28, under the presidency of Dr. J. L. Jones. The academy is divided into sections: Geology, Psychology, Sociology, Languages, Medicine and Health and Churches, Missions and Welfare. There were two general sessions, the first on the evening of June 26, when addresses were given by A. C. Carpenter, Arthur Bridwell and H. Pyle, after which Dr. J. L. Jones gave his presidential address, which was entitled "The Poisonous Snakes and Insects of this Region." The second general session on the following evening was devoted to the general sciences and to law. The opening was announced of a small laboratory at the Institute of Sciences, to be known as the "Edward J. Petry Biological Laboratory." The late Dr. Petry, who was professor of botany at Coe College, Cedar Rapids, Iowa, had frequently lectured at the Junior College. Mrs. Dora Petry, who was present, presented gifts to the laboratory from Dr. Petry's laboratory and library.

THE program of Advanced Instruction and Research in Mechanics now being carried on at Brown University in a twelve-week session will be continued throughout the academic year 1941–42. An expert faculty is being engaged and the courses (four in number plus two seminars) will each semester parallel to some extent those given in the summer. The work is planned so that participants can profit by one, two or three terms. The number of persons who can be accepted is less than the 60 who are registered for the Summer Session, and already a considerable number have applied for admission. Because of the subventions, there will be no charges for tuition in any of the courses; this remission is the equivalent of a scholarship of several hundred dollars for each of the semesters. In addition, students will be eligible to apply for fellowships ranging in size up to $600 for the year. Information may be obtained from the Dean of the Graduate School.

ACCORDING to the report of the Alfred P. Sloan Foundation for the year 1940, grants authorized by the foundation during the year included the sum of $338,221 for some phase of American economic education and research. The recipients of grants were New York University, $55,085; the University of Denver, $51,988; Stephens College, $47,350; the University of Chicago, $46,718; Affairs Committee, $44,946; Massachusetts Institute of Technology, $32,500; Brookings Institution, $25,000, and the University of Pennsylvania, $15,455.

THE *Journal* of the American Medical Association reports that under the will of George Herbert Jones, Chicago, one of the founders of the Inland Steel Company, about $1,000,000 has been set aside to "promote scientific research to alleviate human suffering, improvement of living and working conditions, improvement of facilities for recreation, and improvement of hygiene and prevention of disease, and to assist care of children, the sick, aged, and helpless; reformations of victims of alcohol and narcotics, ex-convicts and wayward persons, and to facilitate work in social and domestic hygiene." The will directs that the income and not more than 10 per cent. of the principal are to be disbursed by the Chicago Community Trust to charities and educational institutions which "best make for the mental, moral, intellectual and physical improvement" of residents of the state. Mr. Jones during his lifetime gave about $4,000,000 to education and medicine.

STANFORD UNIVERSITY SCHOOL OF MEDICINE announces a series of Post Graduate Courses in Medicine, to be given from September 8 to 12 at the Stanford Medical School, in cooperation with the San Francisco Department of Health and the San Francisco Hospital. They include: Gynecology, Medical Diagnosis and Treatment, Diseases of the Genito-Urinary Tract, Diagnosis and Treatment of Malignant Tumors, Cardiovascular Diseases, Surgical Anatomy and Operative Technic, Surgical Emergencies, Traumatic Injuries and Fractures, Ophthalmology, and Anesthesiology. These courses are designed primarily for practicing physicians and are of the review or refresher type. Intensive instruction covering physiology, pathology, diagnostic procedures, as well as therapy, will be given by members of the faculty of the Medical School.

DISCUSSION

THE HIGH WAX CONTENT OF GREEN LINT COTTON

THE lint from *Gossypium hirsutum* (var. Arkansas green lint),[1] described by Ware,[2] differs from that of ordinary strains of upland cotton not only in its bright green color and soft feel to the touch but also in its remarkably high wax content. Whereas the wax content of most cotton lint varies within the range of from 0.4 to 0.7 per cent.[3] that of green lint cotton, based on the dry weight, has been found to vary within the high limits of from 14 to 17 per cent. This high wax content was discovered accidentatlly by the writer in connection with some inquiries into the source of different hues of fluorescence when cotton fiber was irradiated with ultraviolet light.

The wax may be removed readily from the lint of green lint cotton with hot ethyl alcohol, chloroform and other organic solvents. It is also quite soluble in hot acetic acid and cold pyridine. With alcohol as well as with most other solvents the hot extract is colored deep amber in transmitted light but fluoresces a deep velvety green in reflected light. However, the green color of the lint is not changed appreciably, if at all, by the extraction. Thus, it has not yet been ascertained whether the green fluorescence of the alcoholic extract is related to the green color of the lint or is entirely independent. When the hot alcoholic solution cools to 50–55° C. most of the wax separates out in poorly defined yellow crystalline flakes. Between crossed nicols the crystals are quite noticeably anisotropic.

By means of 95 per cent. ethyl alcohol and ethyl ether at room temperature it is possible to separate the crude wax into at least three fractions of different properties (Table 1):

TABLE 1

Fraction no.	Approx. per cent. of total	Solubility at room temperature	Melting point of solid ° C.	Transmitted color of hot alcoholic solution	Velvety green fluorescence in reflected light
1	30	Moderate in alcohol	85–89	light green	inappreciable
2	50	Slight in alc., large in ether	86.5–90	golden brown	moderate
3	20	Slight in both alc. and ether	93–95	very dark brown	very strong

It seems quite likely that fraction 2 contains small amounts of the substance responsible for the dark color and deep velvety green fluorescence of fraction 3. The latter fraction is practically insoluble in ethyl ether, even at boiling temperature and thus can be readily separated from the other two fractions. The very deep color of its solutions is not removed by wood or animal charcoal. A Salkowski test for phytosterol in this fraction was negative. All fractions have a remarkably high melting point compared with other naturally occurring waxes.

X-ray diffraction patterns show that a least a part of the wax occurs in a crystalline form in the fiber and is quite highly oriented, the most prominent diffraction arcs arising from crystal planes perpendicular to the fiber axis; this is the same as Berkley[4] found for the primary wall patterns of white upland varieties. The green lint cotton differs from the other varieties, however, in that a strong wax pattern persists even with the mature fiber.

Microscopic observation of the fibers in longitudinal mount or of their cross-sections does not reveal definitely the location of the wax. In cross-section an outer greenish translucent ring which constitutes one third to one fourth of the thickness of the wall may be observed on sharply focusing. When the fiber cross-sections are strongly swollen with cuprammonium solution a number of similar greenish translucent concentric rings may be seen throughout the wall. Thus far it has not been possible to identify any definite layer of the wall in which the waxy constituents may be considered to be concentrated.

A larger quantity of the wax has been collected for identification of the components.

CARL M. CONRAD
U. S. DEPARTMENT OF AGRICULTURE

[1] The samples were furnished by Dr. J. W. Neely through Dr. J. O. Ware, both of the Bureau of Plant Industry, U. S. Department of Agriculture.
[2] *Jour. Amer. Soc. Agron.*, 24: 550, 1932.
[3] Shirley Institute Memoirs, 4: 107–113, 1925.
[4] *Textile Research*, 9: 355–373, 1939.

POLIOMYELITIS IN A LABORATORY WORKER EXPOSED TO THE VIRUS[1]

ONE of our associates, a woman 35 years old, has developed paralytic poliomyelitis under circumstances which make it highly probable that the infection was contracted in the laboratory. The purpose of this preliminary report is to inform investigators, who may be engaged in work with poliomyelitis virus of human or recent human origin during the next two or three months, of the possibility of laboratory infection in order that they may take precautions which ordinarily might not have been observed. In the more than thirty years of experimental work on poliomyelitis there has not been a single instance of infection as a result of exposure to the virus in the laboratory. Since adults are relatively resistant and since most of the work has been done with rhesus monkeys and with monkey-adapted strains of virus, it is possible that the

[1] Aided by a grant from the National Foundation for Infantile Paralysis, Inc.

conditions were not especially conducive to laboratory infection. In recent years, however, an increasing number of investigators have turned to the study of the human disease and of the behavior of virus of recent human origin in chimpanzees and monkeys of species other than rhesus. It was during the course of work on cynomolgus monkeys which had developed poliomyelitis following the oral feeding of a strain of virus isolated from a child in 1940, that our associate, B. J., contracted poliomyelitis. We have discovered in recent weeks that in these monkeys readily demonstrable virus was present in the buccal, lingual, pharyngeal and intestinal tissues and contents, and B. J.'s duties included the washing and grinding of these tissues in preparation for inoculation into other monkeys.

The circumstances of the illness are as follows: B. J. was working with these infected tissues until June 14, when she left the laboratory to go on her vacation. On June 25, she first felt indisposed with slight headache and nausea. On June 27 and 28 she went to bed because of general malaise and severe backache. On June 29, partial paralysis of the right leg appeared. In the next few days the temperature varied between 102 and 104 degrees Fahrenheit, and there was extension of paralysis involving the entire right lower and upper extremities, the urinary bladder, part of the left lower extremity and partial ptosis and small pupil on the right side with transitory diplopia. Spinal puncture revealed 192 cells per cu mm of cerebrospinal fluid. On July 3, the temperature returned to normal and no further progression of paralysis occurred. Virulent poliomyelitis virus was isolated from her on two occasions; first from a stool specimen obtained 24 hours after the onset of paralysis and the second time from the rectal and colonic washings, containing almost no solid matter, 3 days after the onset of paralysis. Extensive flaccid paralysis with typical histological changes in the spinal cord was produced in both cynomolgus monkeys and positive passage was obtained in each instance. The virus was not pathogenic for mice or guinea-pigs. It may be added that no outbreaks of poliomyelitis had been reported either in Cincinnati or the other places visited by her.

While other studies are still in progress, we believe that the balance of probability in this case is that the infection was contracted in the laboratory. Therefore, we wish to caution other investigators to observe the greatest care not only in handling tissues or excreta of human beings with poliomyelitis but also in working with monkeys (especially cynomolgi or related species) infected with virus of human or recent human origin. This may particularly apply when such virus is given by mouth or reaches the alimentary tract following nasal instillation, which is part of the method now commonly used in testing for the virus in human stools.

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ANOPHELES (KERTESZIA) BELLATOR D. & K., FOUND NATURALLY INFECTED WITH PLASMODIUM

IN the cocoa-raising districts of Trinidad, *Anopheles bellator* is the most abundant *Anopheles* mosquito; it breeds in the epiphytic Bromeliads which grow in great numbers on the lofty immortelle trees that shade the cocoa trees. The malaria rates in these areas are often high, and this mosquito has been suspected of being the vector. It is active during the twilight hours, and at that time attacks man in houses as well as out of doors. Unlike many other anthropophilous Anophelines, *A. bellator,* although it will enter houses and even bed-nets to feed on man, does not remain in houses after it has fed, but returns immediately to its resting places in the forests. Because of this habit, it is impossible to obtain freshly engorged specimens for determining the natural malarial infection rates among these insects; the females must be caught while they attack either the collector or another person being used as bait. Almost all the specimens captured by the authors appeared to be young females taking their first blood meals, but the 398th specimen dissected was infected with a single large oocyst, which ruptured as a result of slight pressure upon the coverslip, and liberated large numbers of motile sporozoites. The mosquito had been collected while it was attacking a native boy, near the Canadian Mission School on the St. Marie Immanuel Road, on July 11, 1941.

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THE PLACE OF MICROFILM COPYING IN LIBRARY ORGANIZATION

THE recently perfected process of making photographic copies of printed pages upon moving picture film is the most economical method so far devised for rendering available to larger numbers of research workers the collections of source material contained in scientific periodicals. It is evident that microfilm copying constitutes a very real improvement and extension of library service and is destined to become an ever-increasing activity in the larger reference libraries. It is fitting, therefore, to discuss the basis upon which it should be undertaken in order to pro-

vide the greatest benefits to research and to the public welfare.

Practically all great reference libraries are maintained largely at public expense or by endowments which have been collected for educational or cultural purposes. Their doors are open freely to all who are able to use their resources for the advancement of science or learning. A reader in one of these libraries is provided usually with a comfortable working place and he is waited upon by a corps of highly trained employees who place at his disposal as many books and as much reference material as may be desired. The reader takes away in his head or in the form of notes such portions of the published material as he needs. There is no charge whatever and in only rare cases is any attempt made to estimate the cost of this part of library operation. This and each of its other functions is looked upon as a public service contributing to the welfare of mankind.

The question now arising in connection with microfilm copying is whether this should be considered in the same light as other services freely rendered by libraries or as something different for which a charge should be collected. Since microfilms are material objects which cost definite amounts to produce it will probably be assumed that they should not be given away like ordinary library service for which no accurate account of its cost can be kept.

Thus the first stumbling block to considering microfilm copying simply as an extension and perfection of library service arises from the circumstance that microfilms are material objects. The fact that the many intangible services rendered by libraries cost a great deal and are performed without charge is generally not considered. The point may also be made, that although the question of just how much service a library should render a reader seldom arises, there might be difficulty in deciding how many microfilms should be made gratis for each person. These are the kinds of problems which make it difficult to include microfilm copying within the category of established library practice.

A question, however, of more fundamental importance for libarians to consider is whether the published reports in their periodical collections can be more efficiently and economically distributed to the many who are able to use them, by means of microfilms rather than by placing the books themselves at the disposal of the relatively few who can come to the library to consult them. It is also important to consider whether or not microfilm copying can be organized in such a manner that its cost will be no greater and possibly less than that required for lending books and maintaining the equipment and service necessary for library readers. In the opinion of those who have had experience with microfilm copying, this appears by no means beyond the realm of possibility. It is an objective worthy of the most serious effort.

Conditions have changed greatly in the organization and functions of reference libraries. The need of going to them to consult the literature has diminished greatly in the United States in recent years. Microfilms seem destined to hasten the day when it will no longer be necessary for any one to go to a reference library to satisfy his needs.

In conclusion the suggestion is made that publicly supported reference libraries eventually should perform microfilm copying for those engaged in research as freely as they now make interlibrary or other loans and provide facilities for consulting their books in their own reading rooms. Many other innovations in library practice were looked upon as dubiously in the beginning as the present suggestion may now be considered. It, however, offers such far-reaching advantages that its general adoption is certain to result in the ever-increasing contribution of libraries to the advancement of research and learning.

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SCIENTIFIC BOOKS

ELECTROENCEPHALOGRAPHY

Atlas of Electroencephalography. By F. A. GIBBS and E. L. GIBBS. 221 pp.; 104 illustrations. Boston: privately printed. $7.00. 1941.

THE "Atlas of Electroencephalography" by Frederick and Erna Gibbs appeared with a timeliness quite unintended by its authors. A few weeks after its publication the man to whom it is dedicated, Hans Berger, the father of electroencephalography, died. The atlas, with its dedication to Berger, will stand as a memorial to him. It will remind future electroencephalographers of the years of quiet, persevering work that preceded Berger's original publication, the polite skepticism with which his work was greeted and its ultimate verification and general acceptance.

Berger has had no more devoted disciples than the Gibbses. From their first year as electrophysiologists in the reviewer's laboratory they have read with care and understanding Berger's long and sometimes difficult papers and have carried Berger's point of view and spirit over into their own work. As they state, the atlas maintains a single point of view, that of the neurologist. They could equally well have said "the point of view of Hans Berger." Theirs is the spirit of exploration and the effort to deduce

information of practical value in the understanding of normal and abnormal function of the human brain from the electrical changes that can be recorded from the surface of the scalp.

The variety of wave-form and pattern of the electroencephalogram must be presented graphically. Words alone are inadequate. In the atlas are hundreds of samples of records, thoughtfully and systematically selected, the digest of six years of experience with thousands of cases. Each record is accompanied by a brief but informative note on the case-history of the subject. Study and comparison are greatly facilitated by the fact that all the records were taken by the same (ink-writer) technique, under similar conditions, at the same speed of tape and usually at approximately the same amplification. All have been skilfully traced by hand and reproduced without reduction in size. The reader is not confused by immaterial and distracting technical differences and can concentrate his attention on the essential waveforms and patterns. In a clear and simple text that occupies part of each left-hand page, the technique and the principles of electroencephalography are presented. The unity of presentation is further preserved by the omission of the Grass-Gibbs spectrum analysis. The authors are to be complimented on their restraint at this point, for valuable and interesting as the frequency-analysis is it would have been confusing to include it in this volume.

Particularly valuable is the long series of records from normal children. Instability, slow waves and irregularity that would be quite abnormal in an adult are perfectly normal in children, and although these differences were first pointed out by Berger and later elaborated by Smith and by Lindsley there has nowhere been so complete a graphic presentation, side by side with records from normal adults.

The variety of records obtained in the convulsive states is equally valuable, including the presentation of questionably normal and even abnormal records from individuals who are and always have been normal as far as convulsions or epileptic conditions are concerned. The principles of localization of gross intracranial lesions are lucidly presented in considerable detail.

The atlas, in spite of its large size, twelve by fifteen inches, too large for any ordinary bookcase, is a "must" for every laboratory or clinic of electrophysiology and for every one who would be really informed on the subject. It is limited to human electroencephalograms, it is true; animal experimentation is represented only in the bibliography. But the bibliography of over six hundred titles is an achievement in its own right and will be of great use to students of the subject.

The text is admirable for its directness and clarity. Readers should appreciate that many of the statements are to be understood as first approximations or as general principles subject to secondary qualifications which are for the present omitted. Some may disagree, for example, with a sharp separation of epileptic patterns into three categories, the petit-mal, the grand-mal and the psychomotor. But the authors point out that the separation is schematic and that a patient may show now one and now another type or mixtures of any two or all three patterns. Perhaps the main fault of the book is its very clarity and simplicity of presentation. It makes electroencephalography look too easy and too much like a finished subject. The atlas should be regarded as a foundation and a starting-point—not as a final goal that has been achieved.

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PSYCHOLOGY

General Psychology. By RAYMOND B. CATTELL. 624 pp. Cambridge, Mass.: Sci-Art Publishers. $3.50. 1941.

THE atmosphere of spirited discussion permeating this book should make it stimulating and provocative to students possessing the necessary command of basic factual material and terminology. While rather careless of details the author takes pains to present both sides of controversial questions, and his own conclusions appear to be fair and judicious. The present achievements of psychology he regards with a decidedly critical eye, but he is enthusiastic regarding the potentialities of this science. Even at present it has very considerable practical value. The applications to psychotherapy, education and industry are presented briefly but at sufficient length to carry some sense of their importance.

In his treatment of cognitive processes the author follows Spearman quite largely, while in the chapters on motivation he develops the ideas of McDougall and Freud with some attention also to Alfred Adler. This general topic with its ramifications is presented with relative fulness, occupying one third of the text. All motives and all behavior, the author believes, "spring from the need of satisfying a few pervasive and biologically indispensable drives." These "ergs," as he prefers to call them, control learning and acquired modifications to a great extent by making it naturally easier for the individual to learn some things than others. Much light on human motives and their conflicts and frustrations has been derived from the study of neurotic patients. Clinical experience affords pragmatic sanction to some at least of the

theories of psychoanalysis, but leaves to the experimental psychologist the duty of putting these theories to a laboratory test, so far as may be possible; and some such experimental work is being done. "All in all, the theories of the pioneers in clinical work give us broader horizons and indicate the probable shape of the things to be investigated; but they can not provide us with a scientific foundation until other more statistical and experimental methods have confirmed them."

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SPECIAL ARTICLES

CHIMPANZEE HANDEDNESS

FEW reports have appeared on preferential hand usage in anthropoid apes; such data as have been presented have derived from scattered, largely non-experimental observations of a few animals. The present inquiry, utilizing 30 chimpanzees as subjects, is an attempt to determine if they use one or the other hand preferentially, how pronounced hand preference is in individual chimpanzees, and how right- and left-handedness is distributed in these animals.

Four test situations, demanding fairly precise, skilful manipulations and designed to preclude the subjects' procuring incentive in any way other than with one hand, were set up. All subjects were tested in their outdoor living cages; each was isolated while being tested. Manipulation (procuring pieces of fruit) was performed by the subjects through the 2-inch square apertures of their wire-netting cage-walls (diagonals of apertures were horizontal and vertical). Test situations were: (*A*) One end of each of 10 parallel strings, each 6 inches long, spaced at 3-inch intervals, was attached 1 inch from the edge of a board 30 inches square; with the strings stretched out on the board and perpendicular to edge of attachment, pieces of fruit were attached to the free ends of the strings; the edge of the board was placed against the cage-wall; hand used by subject in pulling- or raking-in each piece of fruit was tabulated; in this (and in the other situations) the board was quickly withdrawn if subject attempted to procure incentive in any way other than with one hand (such as with lips, feet or both hands); (*B*) 10 small pieces of fruit, spaced at 3-inch intervals and 1 inch from edge of board, were presented; (*C*) small pieces of fruit were placed individually under a small metal box which was hinged at end away from subject; subject procured incentive by reaching through a rectangular hole (1½ inches wide, 2 inches high) in a piece of ¼-inch plywood and upsetting metal box; hand so used was scored "preferred"; and (*D*) pieces of fruit were presented individually on a board 1 inch from cage-netting. Situation *A* was presented until subject had procured 100 pieces of fruit, then Situation *B* until subject had procured 100 pieces of fruit, and so on in the sequence *A-B-C-D-D-C-B-A*. Thus, for each subject, hand used was tabulated for 800 manipulations. Subjects were given 100 trials in a single session in one day, were not tested on immediately succeeding days.

Of the 30 chimpanzees tested, there were 22 adult females, 4 adult males (Bokar, Frank, Jack, Pan), 2 adolescent females (Beta, Gamma), 1 five-year-old female (Dina), and 1 three-year-old male (Fin).

Fig. 1, a bar diagram, shows the distribution of *right* hand use among the subjects for the combined trials of all situations (*i.e.*, the number of times in 800 trials each subject used right hand).

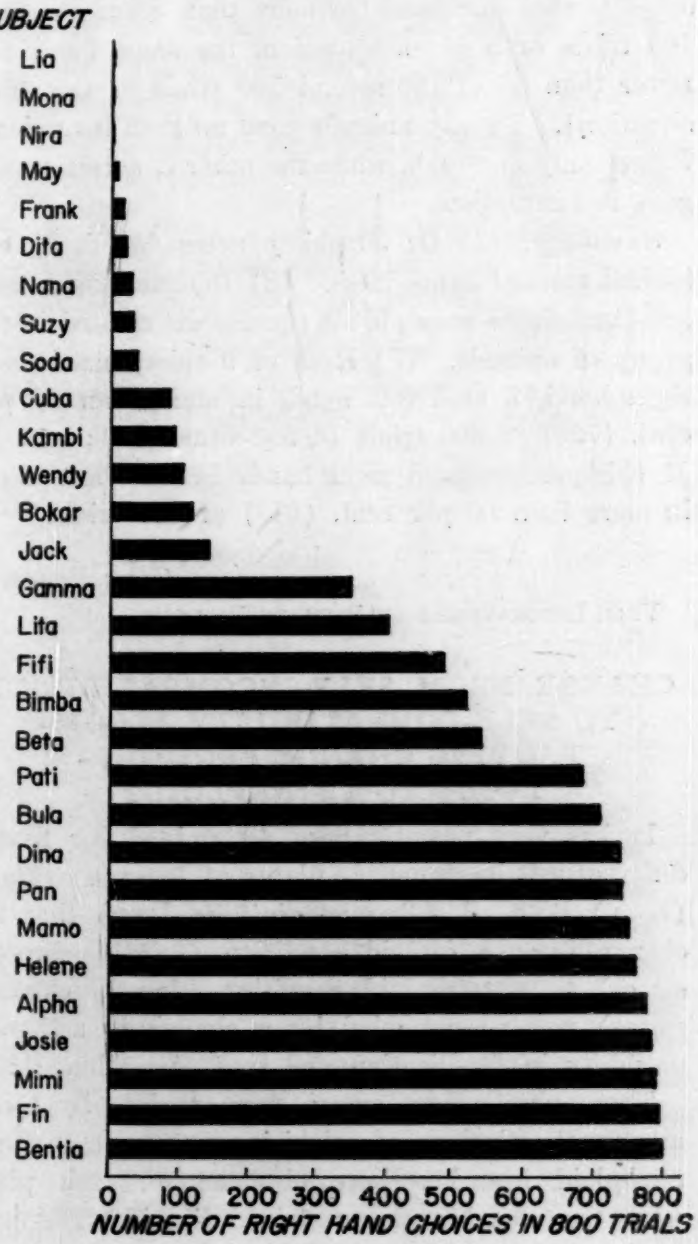

FIG. 1

From this figure, it will be seen that 18 of the 30 subjects used one hand (9 used right; 9, left) in more than 90 per cent. (720) of the 800 trials, and that 25 used one hand (11 used right; 14, left) in more than 80 per cent. (640) of the 800 trials. Examination of the protocols of the 5 animals (Gamma, Lita, Fifi, Bimba, Beta) who exhibited least-pronounced unilateral preference, shows that their detected low-handedness scores are largely attributable to low inter-test agreement, although low single-test reliability also contributes to their attenuation.

Admittedly, increasing the number of test-situations should result in a more adequate determination of chimpanzee handedness; however, the present work does not pretend to explore more than a rather narrowly limited aspect of chimpanzee lateral organization. So far as test-reliability is concerned, precise mathematical statement is difficult because of the bimodality of the distributions involved; test-retest scores of Situations *C* and *D* each show handedness shifts for one subject, *A* for 5, *B* for 6 subjects (*i.e.*, subjects used one hand for more than 50 of the first 100 trials of a given situation, the same hand for fewer than 50 of the second 100 trials of the same situation). Twenty animals gave no such inversions, 7 gave only one each, while the other 3 animals each gave two inversions.

Summary: (1) Of 30 chimpanzees tested, 25 exhibited marked handedness. (2) Detected right- and left-handedness were almost equally distributed in the group of animals. (3) Each of 9 chimpanzees used right hand, 9 used left hand, in more than 90 per cent. (720) of 800 trials (4 test-situations); each of 11 chimpanzees used right hand, 14 used left hand, in more than 80 per cent. (640) of 800 trials.

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CHANGE FROM SELF-INCOMPATIBILITY TO SELF-COMPATIBILITY ACCOMPANYING CHANGE FROM DIPLOIDY TO TETRAPLOIDY

IT has very recently been determined for fifteen different self-incompatible plants of *Petunia axillaris* (Lam.) B. S. P. (*P. nyctaginifolia* Juss.) that the change from a diploid condition (2n = 14 chromosomes) to a tetraploid condition (4n = 28 chromosomes) was accompanied by a change to self-compatibility in fertilization and seed formation.

These plants were grown from seeds. By treatment with solutions of colchicine from one to three tetraploid branches were obtained on each plant while the other branches remained diploid. The flowers on the tetraploid branches were somewhat larger than those on the diploid branches and their pollen grains were larger and many had four germinal pores instead of three. The diploid and the tetraploid conditions were verified for several of the plants by counts of the chromosomes in pollen mother cells during stages of the reduction divisions.

For all these plants the results of controlled and proper pollinations demonstrated that the normal and potentially highly fertile flowers of the diploid branches were self-incompatible and produced no seeds or even rudimentary capsules to normal self-pollination but that the self-pollinated flowers of tetraploid branches on the same plants produced extra large capsules that were well filled with seeds.

Pistils of flowers on the self-incompatible diploid branches developed into capsules with many seeds when pollinated from flowers of tetraploid branches on the same plant. But all tests thus far made for tetraploid × diploid combinations on the same plant have failed to yield any seeds. Also unpollinated pistils of emasculated flowers set no seed either on diploid or on tetraploid branches.

Numerous studies in recent years have demonstrated that the physiological reactions of both self-incompatibility and cross-incompatibility within many species of homomorphic flowering plants are correlated with, and determined by, special hereditary factors and that incompatible reactions involve genetic similarity in respect to special factors or combinations of them.

For the fifteen plants here reported each is self-incompatible in its diploid branches. In the cells of the tetraploid branches on each of these plants there is a duplication of the chromosomes and also, presumably, of the genetic factors which produce self-incompatibility. But this duplication results in a reversal in the reactions of fertilization, and at least one, if not more, of the classes of pollen that segregate from the tetraploid complex is able to function in the production of seed after self-pollination.

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THE PHOTOCHEMICAL SPECTRUM OF CYTOCHROME OXIDASE IN HEART MUSCLE[1]

THE respiratory ferment of yeast and acetic acid bacteria has been shown by Warburg and his associates[2] to exhibit a photochemical absorption spectrum

[1] This work was carried out by the author during the tenure of a Finney-Howell Research Foundation Fellowship (1939–41). It was aided by a grant made to Dr. Kurt G. Stern by the Jane Coffin Childs Memorial Fund for Medical Research.

[2] O. Warburg and E. Negelein, *Biochem. Zeitschr.*, 214: 64, 1929. F. Kubowitz and E. Haas, *ibid.*, 255: 247, 1932.

typical for pheohemin proteins. The values obtained by these workers[3] for rat retina represent points on the spectrum of the Pasteur enzyme (Stern and Melnick[4]). The respiratory ferment in animal tissues is generally identified with cytochrome oxidase, which catalyzes the oxidation of cytochrome c.

For an investigation of the spectrum of cytochrome oxidase in mammalian tissue, phosphate extracts (pH 7.3) of rat heart muscle were chosen; succinate served as substrate. The extracts contained an excess of cytochrome c. Although the overall reaction is the oxidation of succinate to fumarate, there is ample evidence to show that this reaction is mediated by the cytochrome-cytochrome oxidase system.[5] CO is a strong inhibitor of cytochrome oxidase in the absence of cells[6]; this inhibition may be relieved by light. Such extracts exhibit a vigorous O_2 uptake in the presence of succinate at temperatures as low as 10°, and consequently lend themselves to the photochemical technique.

The arrangement of the photochemical apparatus and the method of charting photochemical absorption spectra have already been described.[2,4] In the present case the photochemical effect consists of an increase in O_2 uptake when rat heart muscle extract, in the presence of succinate and a gas phase of 95 per cent. CO and 5 per cent. O_2, is subjected to strong monochromatic illumination. The relative light absorption coefficients as referred to a standard wave-length ($\beta\lambda/\beta_{436}$) were calculated for twenty-three wavelengths.

The data show that cytochrome oxidase from a mammalian source, like the respiratory ferment in yeast and in bacteria, exhibits a spectrum characteristic of pheohemin compounds. There is a steep Soret or γ-band in the blue at 450 mμ, and two secondary maxima, the β-band in the blue-green at 510 mμ and the α-band in the yellow at 589 mμ. The thermolability of the enzyme suggests that the hemin grouping is combined with a protein. In spite of the similarity of the spectral patterns of these enzymes, there exist significant differences in details, indicating that they are not identical. Thus the position of the main absorption band is at 450 mμ in the instance of the enzyme of heart muscle and at 430 mμ for that in acetic acid bacteria and in yeast.[2,7]

It is of interest to note that the Pasteur enzyme of rat retina also has its main absorption band at 450 mμ[4]; however, its non-identity with rat heart muscle cytochrome oxidase is indicated by the fact that the α-bands are located at different positions, namely, at 578 mμ for the Pasteur enzyme and at 589 mμ for cytochrome oxidase. A similar situation exists in the yeast cell where the γ-bands of the Pasteur enzyme and the respiratory ferment coincide, whereas the structure of the α-bands differs significantly.[7]

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[3] O. Warburg and E. Negelein, *ibid.*, 214: 101, 1929.
[4] K. G. Stern and J. L. Melnick, *Jour. Biol. Chem.*, 139: 301, 1941.
[5] D. Keilin and E. F. Hartree, *Proc. Roy. Soc. Series B*, 127: 167, 1939.
[6] *Ibid.*, 125: 171, 1938.
[7] J. L. Melnick, *Proc. Am. Soc. Biol. Chem., 35th Annual Meeting*, 1941, p. 90.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

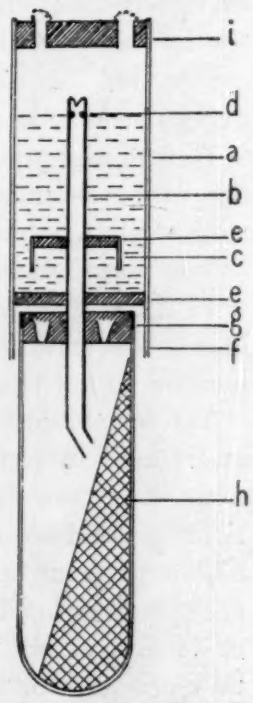
THE EXAMINATION OF CONTAMINATED WATERS[1]

A RAPID method has been devised to speed up the routine bacteriological examination of water from an average of 48 to 96 hours to 8 to 10 hours. The sample is inoculated into routine presumptive lactose broth, then transferred at the optimum time to a confirmation media, either liquid or solid. No difficulty has been experienced in obtaining discrete colonies. The ordinary laboratory glassware is used to assemble this very simple apparatus. Both presumptive and confirmation media can be sterilized and handled as a single unit. Other types have been developed for special purposes.

The principle of this method is the utilization of gas produced by fermentation in the presumptive media to cause a small amount of enriched inoculum to overflow into a conductor tube, automatically inoculating the

FIG. 1

"a" Presumptive tube containing Lactose Broth.
"b" Conductor tube.
"c" Fermentation vial.
"d" Limiting level mark; = height of water + media.
"e" One hole rubber stoppers.
"f" Glass skirt; continuation of presumptive tube.
"g" Rubber stopper notched along edge to admit air.
"h" Confirmation media; solid E.M.B. slant, or liquid B.G.B.
"i" Two-hole rubber stopper with cotton plugs.



[1] Preliminary report.

confirmation media. It should be understood that since the success of this method depends upon the formation of certain minimum amounts of gas those samples having very few organisms, or predominatingly slow lactose fermenters, must necessarily take a longer period of time for completion of the test. Speed is enhanced by using larger samples for only slightly contaminated waters.

The governing factors are: (1) concentration of organisms in inoculum; (2) size of fermentation vial which regulates the amount of liquid which will overflow into conductor tube; (3) height of limiting level mark; (4) diameter and shape of conductor tube; (5) length of time inoculum is enriched before passing into conductor tube, 4 hours found to be optimum time. All these factors are controllable.

With this method, mobile laboratories are enabled to collect a flock of samples on one day and are ready to move again the next morning when the tests are completed. Positive tests on ships' supplies may be accomplished overnight as compared with 48 to 96 hours. In a large distribution system, water leaving the reservoirs may be tested with ensuing results obtained sufficiently early to regulate the supply before it reaches the end of the distribution system.

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PERMANENT MOUNTS OF VIRUS-INFECTED CHORIOALLANTOIC MEMBRANES

THE chorioallantoic membrane of chick embryos has become an important tissue for the cultivation of viruses. The lesions produced are in many cases characteristic of the infecting virus. There is a need for an easy method of permanently mounting such membranes. A method is here described which has proven itself to be satisfactory.

The mounting material is prepared by slowly pouring, with constant stirring, 50 gm of powdered isobutyl methacrylate polymer[1] into 100 cc of xylol. The mixture is placed in the incubator and stirred at intervals until it becomes clear. This takes about an hour. A higher concentration of the plastic is less good, as air bubbles do not rise well to the surface.

The membranes are harvested in the usual manner and rinsed in physiological saline or Tyrode's solution. They are then passed through a series of dilutions of ethyl alcohol, 5, 10, 15, 20, 25, 30, 40, 50, 65, 85, 95 per cent. and, finally, absolute alcohol. They are spread out and left in each dilution for 15 minutes or longer, except for the absolute alcohol in which they are left for at least half an hour. Just before mounting they are transferred from the latter to xylol, where they are left for five minutes. About 5 cc of the solution of plastic is poured into the bottom of a Petri dish. The membranes are drained slightly and spread out in this. A paper label may be embedded beside them. This may be typewritten or marked with pencil, ink or india ink. The Petri dish is set aside to dry in a dust-free place. A second layer of plastic is added to cover all irregularities. When this has hardened, the cover of the Petri dish is put on to protect the surface from dust and injury.

When the membranes are passed through fewer dilutions of alcohol or more rapidly, the normal parts do not remain as clear and the lesions do not show as well. Other solvents were tried, but none gave better results than xylol.

No difficulty is experienced from curling of the membranes. In membranes with considerable edema there is a shrinkage of 10 to 15 per cent., but in normal ones or in those with little edema there is no shrinkage.

This method produces a solid mount which can be easily handled and examined. The areas of hyperplasia due to virus infection stand out in sharp contrast to the surrounding tissue.[2]

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[1] Manufactured by E. I. du Pont de Nemours and Company, Wilmington, Del.

[2] I wish to express my appreciation for the valuable suggestions of Dr. Maurice N. Richter. This work was conducted under a grant for virus research from the Lambert Pharmacal Company, St. Louis, Mo.

CORRECTION

IN Table 2 of the article "Prevention of Tumor Growth (Carcinoma 2163) by Intravenous Injections of Yeast and Vitamins" (SCIENCE, July 18, 1941) the per cent. figures for non-takes should read: Yeast + Riboflavin 62%, Yeast 21%, Riboflavin 14%, Yeast + Thiamin 18%, Thiamin 3%.

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